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Author: Ms. Aloisia Russo
Politecnico di Milano, Italy, aloisia.russo@mail.polimi.it

Dr. Pierluigi Di Lizia
Politecnico di Milano, Italy, pierluigi.dilizia@polimi.it
Prof. David Barnhart
University of Southern California, United States, barnhart@isi.edu

MULTI-FUNCTIONAL SELF-RECONFIGURABLE ROBOTIC ARM (RAMSES) AND ADJOINED SOLAR PANEL PRELIMINARY DESIGN FOR LUNAR ENTRY APPROACH PLATFORM FOR RESEARCH ON GROUND (LEAPFROG)

Abstract

As space technologies are advancing the next challenging mission is to bring humans to Mars, paving the way for other deep-space destinations. Work on the Moon is a good test-bed for Mars as it can provide an opportunity to demonstrate new technologies that could help build self-sustaining outposts: the key success lies in international collaboration to achieve sustainability through the use of reusable architectures, and the capability to utilize Moon resources to create a permanent Lunar base. In this context, a reusable and completely autonomous lander capable of performing multiple tasks on the Moon's surface can help to accomplish the aforementioned objective.

One of the projects exploring this new construct is from USC's Space Engineering Research Center (SERC) in its Lunar Entry and Approach Platform for Research on Ground (LEAPFROG) testbed. This is a hands-on project for students to simulate flight and ground activities for the lunar environment through tech generations as a repeatable flight system that uses a jet engine to simulate flight in lunar gravity on Earth. LEAPFROG Generation-II goal is to re-think the function of a lander so that it can perform multiple activities with the same mass after landing.

A Master of Science research thesis in exploiting the capability of changing a single monolithic functioning lunar lander into a multi-functional platform is presented. This paper will focus on the design of Multi-functional SElf-reconfigurable Robotic Arm (RAMSEs) with 7 degrees of freedom (DOF) as well as a unique adjoined solar panel design. RAMSEs will be capable of performing different soil activities after landing (i.e. to take samples, to drill, to dig, etc.), and before landing acting as a secondary structure on fuel tanks during the flight mode. A kirigami inspired solar panel design is also presented that is manipulated by the arm, which also serves two functions. The research aim is to find the most suitable configuration of RAMSEs as well as the most compact and functional design for the on-board solar panel. Simulink simulations will prove the RAMSEs capability to follow a prescribed trajectory which links tools allocated on-board points and their final point to perform the pre-selected activity. To deploy the dual function solar panel, an origami-based structure is used to extends six times its folded configuration to save space on-board while its usage is not required. This high-utility low-cost concept will be proven through a 3D-printed testbed described in the paper.